Ohio Agricultural Experiment Station.

BULLETIN 79

WOOSTER, OHIO, APRIL, 1897.

SOME DISEASES

OF

ORCHARD AND GARDEN FRUITS.

WITH SPRAY CALENDAR SUPPLEMENT.

The Bulletins of this Station are sent free to all residents of the State who request them. Persons who may receive duplicate copies, or who do not care to receive any, are requested to notify the Station All correspondence should be addressed to

EXPERIMENT STATION, WOOSTER, OHIO

NORWALK, OHIO:
THE LANING PRINTING CO.
1897.

ORGANIZATION OF THE

OHIO AGRICULTURAL EXPERIMENT STATION.

BOARD OF CONTROL.

SETH H. ELLIS.....Springboro
R. H. WARDER.....North Bend
J. F. ROBINSON.....Rockaway
THE GOVERNOR OF THE STATE
THE DIRECTOR OF THE STATION } .....*Ex officio*

OFFICERS OF THE BOARD.

SETH H. ELLIS.....President
R. H. WARDER.....Secretary
PERCY A. HINMAN.....Treasurer

STATION STAFF.

CHARLES E. THORNE	Wooster	Director
WILLIAM J. GREEN	"	Horticulturist and Vice-Director
J. FREMONT HICKMAN, M. A. S	"	Agriculturist
FRANCIS M. WEBSTER, M. S	"	Entomologist
AUGUSTINE D. SELBY, B. Sc	"	Botanist and Chemist
LLOYD M. BLOOMFIELD, B. AGR	"	Assistant Chemist
CHARLES W. MALLY, M. Sc	"	Assistant Entomologist
PERCY A. HINMAN	"	Bursar
WILLIAM HOLMES	"	Foreman of Farm
CHARLES A. PATTON	"	Ass't Foreman and Meteorologist
W. A. PORTER	"	Florist
DELBERT A. CROWNER, B. Sc. AGR	"	Dairyman
ANNIE B. AYRES	"	Mailing Clerk
S. J. BLAKE	"	Mechanic
J. E. BARCLAY	Neapolis	Supt. Northwestern Sub-Station
EDWARD MOHN	Strongsville	Supt. Northeastern Sub-Station

The Bulletins of this Station are issued at irregular intervals. They are paged consecutively, and an index is included with the Anuual Report, which constitutes the final number of each yearly volume.

BULLETIN

OF THE

Ohio Agricultural Experiment Station.

NUMBER 79. APRIL, 1897.

SOME DISEASES OF ORCHARD AND GARDEN FRUITS.

BY AUGUSTINE D. SELBY.

The discussions and observations offered in this paper are a continuation of those given in Bulletin 73, and deal with a part of the diseases of those "orchard and garden fruits" which have woody stems. Diseases of the peach will receive separate treatment. No statements are presented except upon diseases that have been under study, although in many cases the results obtained are far from satisfactory or complete. The larger share of the troubles described are likely to demand treatment during the coming season. The wish to have the collected material published in time to be of use in fungicidal treatment has induced preparation at this time.

It will be seen that Bordeaux mixture is the fungicide most highly recommended. Its use is advised, where admissible, in preference to other fungicides because it has, in most cases, proven superior to them. The ease with which the materials may be secured as well as their price make it even more available upon grounds of convenience. Its thorough adhesion when applied is sufficient compensation for the slightly increased difficulty in its application. Professor Green[1], the Station Horticulturist, has made extended trials of various mixtures; these results are already known.

The 75 gallon formula, or dilute Bordeaux mixture, is that referred to in the subsequent pages, where no further specification is made.

DIRECTIONS FOR MAKING DILUTE BORDEAUX MIXTURE: 75 GALLON FORMULA.

Ingredients: Copper sulfate (blue vitriol), 4 pounds; quick lime (not air slaked), 4 pounds; water, to make 50 gallons.

Dissolve the copper sulfate in about two gallons of hot water contained in a wooden vessel, with stirring, or even better, by suspending the sulfate contained in a cheese cloth bag, in a large bucketful of cold water. With the cold water and cheese cloth bag, longer time is required. Pour the sulfate solution into the barrel

[1]Bulletins of the Ohio Experiment Station: IV, 9, 1891; No. 48, 1893; No. 63, 1895.

or tank used for spraying, and fill one-third to one-half full of water. Slake the lime by addition of a small quantity of water, and when slaked cover freely with water and stir. Pour the milk of lime thus made into the copper sulfate, first straining it through a brass wire strainer of about 30 meshes to the inch. Pour more water over the remaining lime, stir, and pour into the other; repeat this operation until all the lime but stone lumps or sand is taken up in the milk of lime. Now add water to make 50 gallons in tank. After thorough agitation, the mixture is ready to apply. The mixture must be made fresh before using and any left over for a time should be thrown out or fresh lime added.

For spraying cherries and peaches in foliage, it is hardly safe to use the strength given. Half the amounts of lime and blue vitriol, or 2 pounds of each to 50 gallons of water, a 150 gallon formula, is strong enough.

A solution of copper sulfate alone will be referred to. It is made as per directions to dissolve the copper sulfate, and the vessel to contain the spraying liquid is entirely filled with water. A strength of 4 pounds of blue vitriol to 50 gallons of water may be used with safety on orchard trees before the buds open in spring.

STOCK SOLUTION.

A solution of copper sulfate containing say 1 pound of sulfate to the gallon of water may be made up and permitted to stand indefinitely in a covered barrel if no lime is added. Such a solution is known as a Stock Solution and two or four gallons of this stock solution, according to the strength desired, are taken for each 50 gallons of mixture to be made. For extensive spraying, a long trough, or box of uniform width may be used in which to slake and keep the lime. The quick lime is weighed out according to the amount needed, placed in the trough and slaked with a small quantity of water. The whole is then evenly spread as a putty, and covered with water to exclude air. This putty may be removed in calculated portions, placed in a tub and treated like the freshly slaked lime. By means of a stock solution of copper sulfate and the lime in putty state, much valuable time is saved in filling the barrels or tanks used in spraying.

I. CERTAIN DISEASES OF CURRANTS AND GOOSEBERRIES.

Currant and gooseberry diseases are treated together for obvious reasons. The troubles mentioned below are such as appear to prevail.

1. PREMATURE DROPPING OF CURRANT LEAVES AND CURRANT LEAF SPOT.

The currant industry has not assumed the importance in Ohio that it may have done in other states, yet large plantations of this fruit are on the increase and small ones are general. Complaint has been made of the spotting of currant leaves in midsummer and the early defoliation of the plants. The illustration, Fig. 1, will show the appearance of spotted

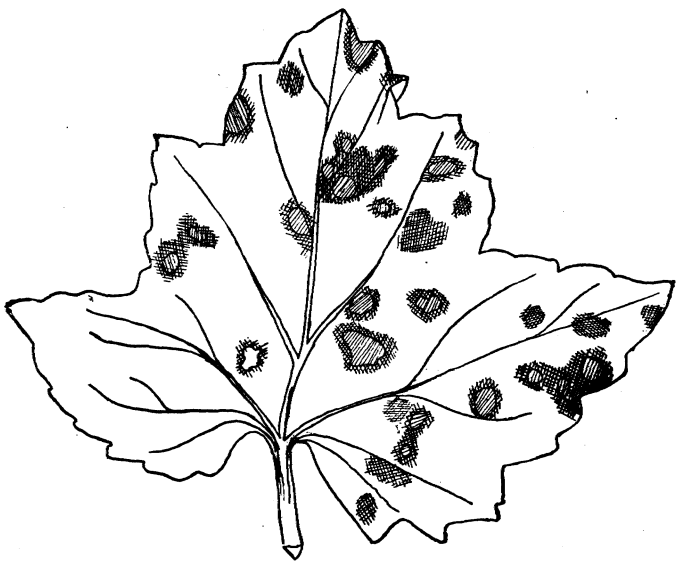


FIG. 1. LEAF SPOT ON FAY CURRANT (Original.)

leaves on Fay and Cherry varieties. On some varieties, as the Red Dutch, the spots are smaller. This was observed on Cherry and Fay currants at Clyde early in June, and the grower reports practically all leaves dropped off August 1st (many of them in June), with but slight growth of wood. Examinations of currants, made in August, in Lucas, Ottawa and Erie counties, showed nearly all the leaves upon the ground. Those that still remained were badly spotted and often more than half the leaf was dead. The same conditions prevailed at Wooster in the Station's plantings.

The trouble which results in spotting and defoliation of the currant is a fungous disease. A parasitic fungus attacks the leaves with the result stated. It appears that we here may have really two species of fungi, the currant leaf spot fungus (*Septoria ribis* Desm.), and the currant cercospora (*Cercospora angulata* Wint.) These have been studied

by Pammel[2] and satisfactory results obtained in Iowa from spraying to prevent their injuries.

Whether the leaf spot fungus (*Septoria ribis* Desm.) alone, or both it and the Cercospora are concerned, my examinations are not entirely conclusive. The Septoria was found upon Fay, Cherry and Red Dutch currants. The fungous character of the disease seems well established. As with other leaf spot troubles the fungus so robs the leaves by its parasitic growth that the affected areas die, thus producing the spotting of the leaves and finally their premature dropping as complained of.

EFFECTS OF PREMATURE DEFOLIATION.

The effect of this early spotting and dropping of the currant leaves is likely to be serious. The loss of foliage in this manner will interfere with the maturity of both wood and buds; the spot in this case can scarcely develop early enough to prevent ripening of the fruit. As a result of early defoliation, the succeeding crop will be injured. The resultant injury to the fruit crop would be proportional to the loss of vigor suffered by the plants. The worst phase of the disease is the cumulative effects; the loss of vigor by the plant will increase with each successive premature defoliation. Not only will the early dropping of leaves have its effect, but the spotting as well. Each dead area subtracts so much from the available leaf surface, and the amount of such loss is large even before the leaves fall.

PREVENTION OF CURRANT LEAF SPOT.

The experiments in Iowa by Pammel[3] show that the currant leaf spot may be prevented successfully by spraying with Bordeaux mixture. In 1891, three sprayings, beginning June 9, and ending July 3, were not sufficient. In 1895, five sprayings, May 10, to July 22, gave satisfactory prevention on all sorts. The Iowa results should be capable of repetition in Ohio. Begin the spraying with Bordeaux mixture as per directions in calendar, from May 1 to 10, and repeat at intervals of about two weeks till about July 20, using care to apply the fungicide to both sides of the leaves. The inference is strongly in favor of profitable treatment of diseased currants with Bordeaux mixture.

2. GOOSEBERRY LEAF SPOT AND POWDERY MILDEW.

The leaves of the gooseberries in the Station gardens were badly spotted the past summer. The leaves also dropped prematurely as described for the currants. The disease in this case appears to be the leaf spot fungus, (*Septoria ribis* Desm.) It should be amenable to the same treatment as that recommended for currants. As with them the

[2]Pammel, L. H., Bulletins Iowa Experiment Station. B. 13, 1891; B. 17, 1892; B. 30, 1895.

[3]Loc. cit. B. 30, pp. 289-291.

treatment, apparently, will be best begun just after the unfolding of the leaves and continued at intervals of two weeks until about five applications of Bordeaux mixture have been made.

Nearly all persons who have endeavored to grow the English varieties of gooseberries in Ohio have had serious difficulty with the powdery mildew, (*Sphærotheca mors-uvæ* (Schw.) B. & C.) The Industry variety, which is planted to some extent, suffers, like its class, from the mildew. The worst case of mildew upon the American sorts was observed in Erie county upon Houghton's seedling. The disease has there prevailed upon it for at least two seasons. August 8, 1896, when the place was visited, the leaves had generally dropped and new foliage had put forth, then having leaves three-fourths of an inch or less across. Most of the stems were spotted with the dense, felted mycelium of the mildew, and these spots were dotted with the dark spore cases containing winter or resting spores. The outlook for a crop in such a garden is not encouraging.

Three sprayings with Bordeaux mixture or potassium sulfid[4] are recommended as sufficient for mildew, but in cases of such severe attack as that just described so small a number might not be enough. An early application, before the buds open in the spring, is strongly recommended in a case like that on the Houghton. Two or three subsequent applications, with care to cover both sides of the leaves and all new growth, may be looked to with reasonable confidence. When the fruit is large it is not advisable to use the Bordeaux mixture, on account of its great adhesion. A solution of potassium sulfid would then be available.

[4] Green, W. J., Bulletin 63, Ohio Experiment Station, p. 106, (1895.)

II. DISEASES OF RASPBERRIES AND BLACKBERRIES.

A discussion of the diseases of the raspberry and blackberry by Miss Detmers was published in October, 1891, in a bulletin of this Station. The diseases treated upon included anthracnose—with two original illustrations—blackberry leaf spot, bramble rust and a bacterial disease due to the organism of pear blight. Conditions have not greatly changed since that date, save by the occurrence of serious root and stem tumors, apparently to be referred to crown gall.

1. ANTHRACNOSE OF RASPBERRY AND BLACKBERRY.

This serious disease of both raspberry and blackberry continues to be very troublesome. Attacking, as it does, the young canes in early summer and spreading upon them, it yet does not appear to affect their growth to any great extent. The following detailed description by Miss Detmers [5] will serve to make plain the general symptoms of the disease:

"The fungus, [*Glœsporium venetum*] was first observed on the black-cap raspberry early in May, when the young shoots were about a foot high. On these shoots, at or near the surface of the ground, appear small purple spots, which are round, distinct, and scattered irregularly on the canes. The spots rapidly increase in size and number, extending around and up the cane, the youngest spots being uppermost. At first purple, they soon become whitish in the centre, with a raised purple border marking the line of separation between the healthy and diseased tissues (Plate I). The white center dies, the border becomes brown, often the spots coalesce, when the dead epidermis ruptures, and we have ragged looking patches of several inches in length and entirely girdling the cane.

"The purple spots also occur on the leaf petiole, veins and leaf tissue. The veins are a little swollen, and the affected petioles curl downwards On the parenchymatous portion of the leaf the spots are much smaller than on the canes.

"The disease is not fatal the first season, nor does it seem to visibly affect the growth of the young canes; but the next season, when last year's young canes bear fruit, its destructiveness becomes but too apparent (Plate II). The effects of the fungus are most noticeable at the time of the ripening of the berries, which do not attain to a normal size, but shrivel, and finally dry up; the leaves are much smaller than healthy ones, and have a generally unhealthy appearance, later turning yellow, then brown. The canes finally become blackened then die.

"The period of most rapid growth for the canes is also the period of greatest development of the fungus. From June until August this rapid development is kept up; then its vigor seems to abate somewhat. During August of this season, after the worst diseased canes had been removed, the others seemed to recover and become much greener than they were before, although fresh spots of the fungus still continued to appear on the young growth. During the latter part of August and first of September the extreme ends of the shoots rapidly turned a purplish black, without showing definite anthracnose spots, and died. The extreme tip blackens first, the discoloration extending down the shoot. The young leaves are stunted and do not open."

Plate I, which is reprinted herewith, will show the botanical characters of the anthracnose fungus, (*Glœsporium venetum*. Speg.)

[5] Detmers, F., Bulletin Ohio Experiment Station, IV, 6, 1891.

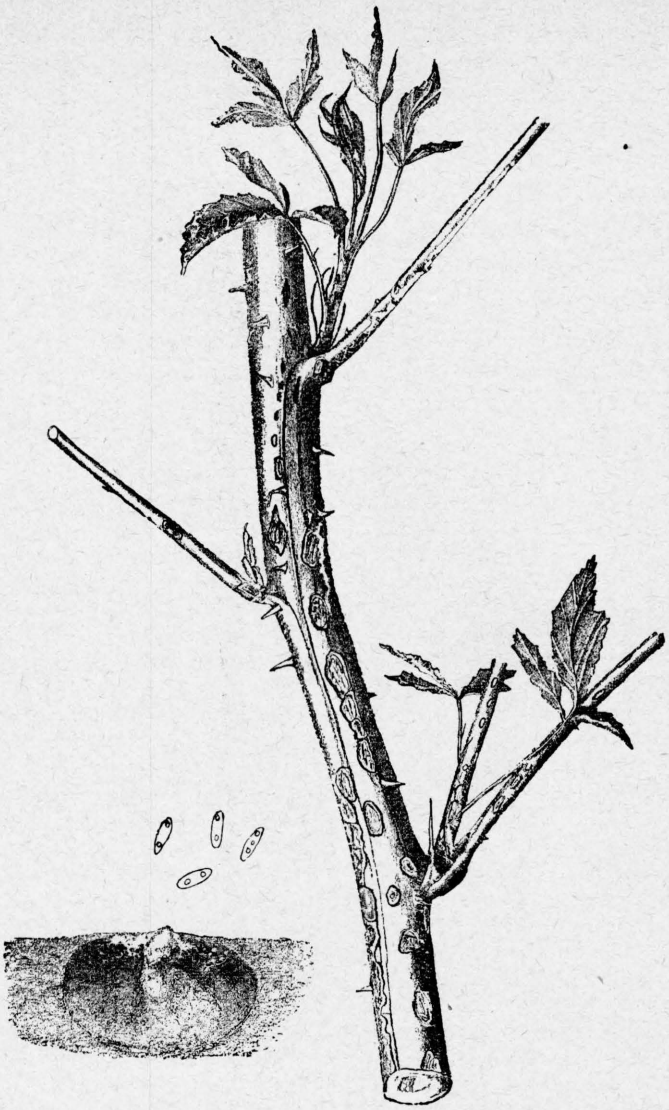


PLATE I.—ANTHRACNOSE OF RASPBERRY.

At the right, a young cane of black-cap raspberry, showing early stages of the disease, natural size. At the left a bursting acervulus of the fungus with spores, magnified.

This page intentionally blank.

PLATE II.—ANTHRACNOSE OF RASPBERRY.

Fruit bearing cane of raspberry, showing leafless, diseased and more healthy branches. Less than natural size.

This page intentionally blank.

The general experience of growers has been that no varieties are exempt and that raspberry plantations seriously affected by this fungus do not yield a profitable return, and, in cases of severe disease, give very few matured berries. The foliage effects are commonly more evident than the stem spots upon blackberry plants.

The results obtained in the treatment of anthracnose seem to be rather contradictory, some reporting little or no effect and others very satisfactory results.

Professor Green's reports have been uniformly favorable to the use of Bordeaux mixture for anthracnose. He has frequently urged the necessity for thoroughness in the application of the mixture. To be successful, care must be taken to apply the mixture upon the young canes during growth and this will surely require spraying from underneath rather than from above. The following are his directions for spraying raspberry plants[6]:

"*Raspberry Plants.*—Spray for the anthracnose. Use Bordeaux mixture once before the leaves open, after which apply it two or three times, half strength, to the young canes only, taking care to keep the mixture off the leaves of the old canes, We have succeeded with this treatment, but many others report indifferent results, for reasons which cannot, at present, be explained."

2. RED RUST OF BLACKBERRIES

This trouble, due to the bramble rust fungus, (*Cæoma nitens,* Schw.), is common everywhere upon wild blackberries. It is frequent in blackberry plantations and infests raspberries as well. Owing to the orange red color which the affected plants exhibit, the disease is called "yellows" in some localities. Its character is to be correctly inferred from the name "rust". The fungus belongs with the rusts. The differences of treatment are such as generally hold with fungi of this group. The yellowish coloring of affected plants may be observed as soon as the leaves appear in spring. The diseased leaves are more or less rolled and the general evidences of the fungus are fairly conspicuous. The enormous number of spores produced by this fungus is well known to most observers. The nature of the disease is such that little or no benefit has been derived from spraying with fungicides. The fungus, indeed, lives from year to year in the affected plants. The best practical treatment, therefore, is to dig out and burn these rusted plants, or stools in which rusted plants occur, as promptly as possible. The object of the removal and burning is to prevent the spread of the trouble to adjacent plants. It is to be inferred from the statements made, that there is little hope of curing a plant or stool once diseased.

3. LEAF SPOT.

The leaves of blackberries, particularly dewberries, and raspberries as well, are often spotted with a disease which shows a small white or

[6]G., Bulletin Ohio Agricultural Experiment Station, 63, 106.

light brown center, a fraction of an inch in diameter, surrounded by a red, discolored border. Close examination of these spots with a magnifying glass will disclose small, dark, pin-head spots upon the upper side of the leaf. These are visible to the unaided eye. This leaf-spot fungus, (*Septoria Rubi* Westd.) is quite generally prevalent upon the trailing wild species of Rubus. It has been frequently observed on the cultivated dewberries of the Eureka type. Should the disease prove serious, it may probably be controlled by the use of Bordeaux mixture.

4. BACTERIAL DISEASE OF THE RASPBERRY.

Miss Detmers, in the article already quoted, treats of a bacterial disease of red raspberry and Snyder blackberry. This was determined by Professor Burrill to be due to the bacterium of pear blight. The effects of this disease are usually visible as brownish, dark patches from one-half inch to several inches long, and extending around the cane quite near the surface of the ground. The disease would be, as is the fire blight of the pear, unlikely to respond to fungicidal treatment. Where plantations are affected seriously, the brush heap would seem the only resort.

5. CROWN GALL.

Galls or tumors upon the roots and stems of both raspberries and blackberries are frequent, and appear to be increasing in frequency; the injuries caused by them are also greater than formerly. The trouble seems to be the same as that called "Crown Gall,"[7] on the Pacific slope. Sometimes the enlargements are upon the canes, extending from near the surface of the ground upward, (1, Pl. III), while another form occurs chiefly upon the roots and at the crown of the plant. (2 Pl. III, also Fig. 2.) A paper upon these was read before the Ohio State Horticultural Society in December, 1895.

Crown gall was first observed upon canes of the Gregg raspberry sent from Fulton county in 1894. These galls were variable in size, ranging from less than a half an inch to more than an inch in diameter. In the photograph the galls are shown quite extended. Diseased plants from this lot were transferred to the greenhouse and similar galls were formed on them. The only organisms discovered in connection with them were eelworms. The eelworms were on the outer portion of the galls below ground but appeared to be in contact with living tissue. Twenty per cent. of the plants in the lot where the gall was first seen were affected at two years of age. The diseased canes often droop very suddenly and rarely mature fruit. The loss, therefore, is large. The plants were set in rather low, enriched, sandy ground and were apparently healthy at planting.

[7]Bulletin 99, Cal. Exp. Sta., 1892, (Woodward.) Bulletin 1, II, Arizona Exp Station, 1894, (Tuomey.)

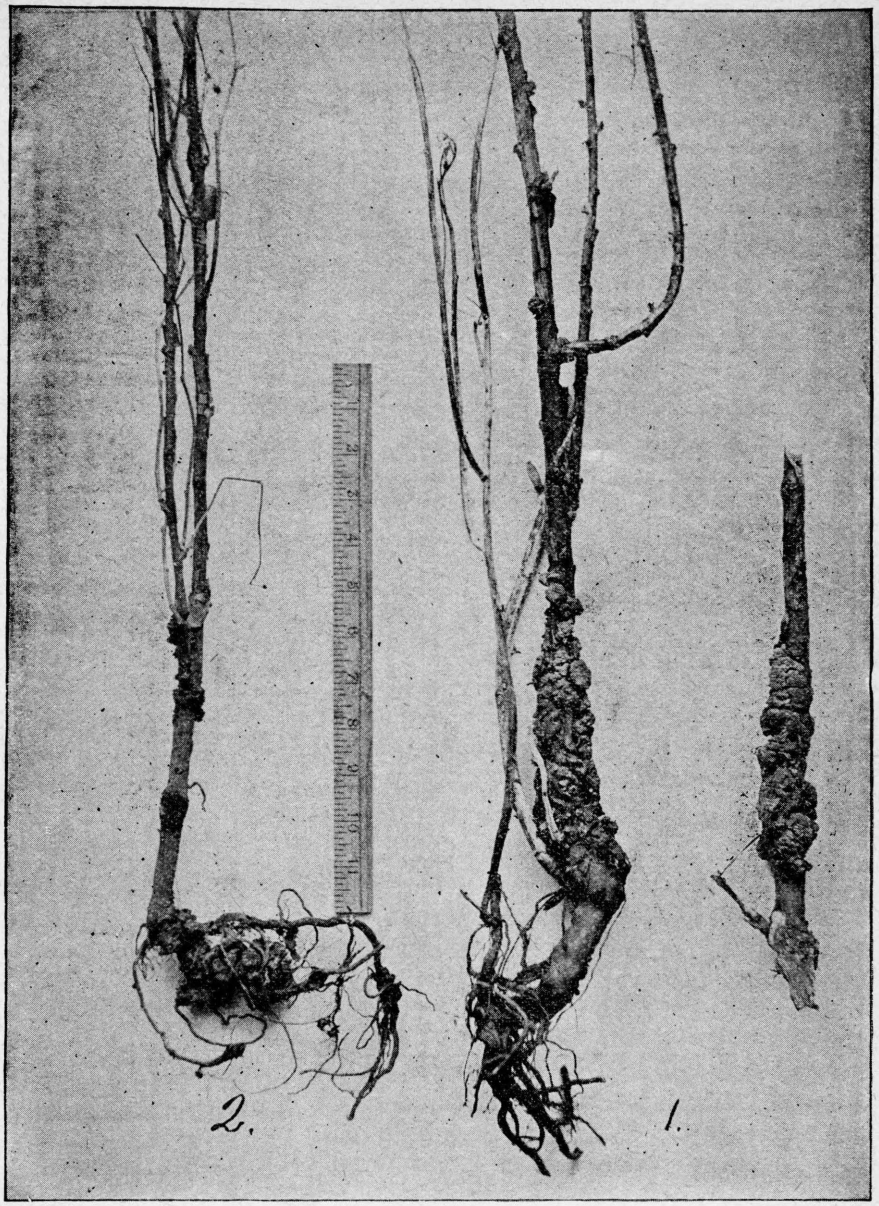


PLATE III.—CROWN GALL OF RASPBERRY.

At 1 are shown plant and stem of Gregg raspberry, with galls largely above ground. Specimen taken in Fulton county, Ohio, July 4, 1895. At 2, a plant of Thompson's Prolific, with galls both below and above ground. Those below apparently due to nematodes. Collected August 21, 1895, in Erie county, Ohio.

This page intentionally blank.

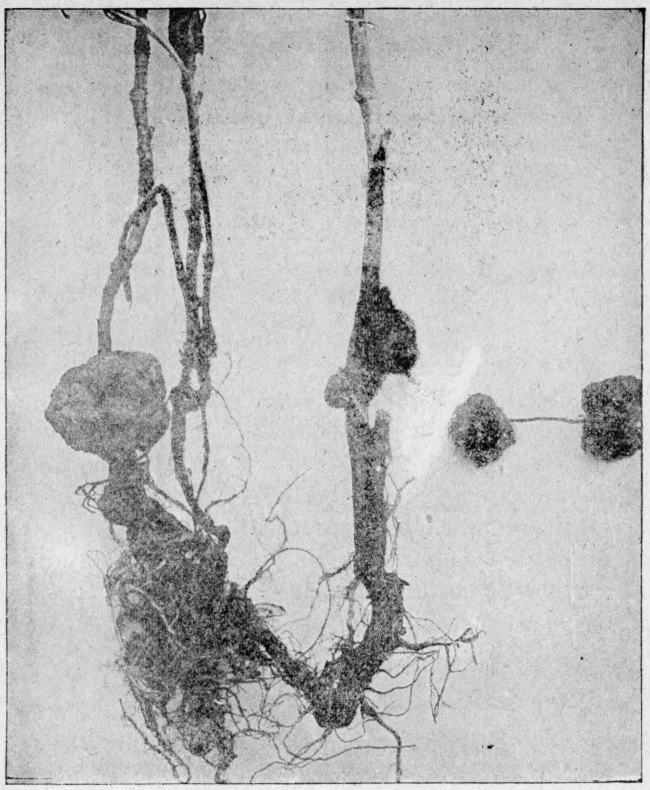


FIG. 2.—NEMATODE CROWN GALL OF RASPBERRY.

The plant at the left is a young cane. The form at the right is less frequent. From Thompson's Prolific (Original).

A second lot, set some miles distant with plants obtained from the diseased plantation, were affected in the same manner. Ten per cent. of these plants were reported diseased at one year old. The trouble appears to have been carried with the plants when reset. The communicable nature of the crown gall is inferred from this circumstance. Instances have been cited by others where the disease spread from raspberries to peach trees.

Thompson's prolific raspberry, in Erie county, was observed to be similarly affected, but with the galls more frequent upon the roots and usually of a spherical form, (Fig. 2) one-half inch to one and one-fourth inches in diameter. In these the galls rarely appear above the surface of the ground (Pl. III, 2.)

It has since developed that several plantations of this variety at Berlin Heights and Florence, all have the same trouble and that all the growers procured the plants from the same source. The plantation from which these plants came was found, on examination, to be diseased in the

same manner. The source and spread of the disease, in these cases, may be inferred from the facts stated.

Repeated examinations of the galls on the Thompson variety, during two seasons, showed that eelworms were present in large numbers. The galls were accordingly attributed to the eelworms. Specimens were afterwards sent to Professor B. T. Galloway, Washington, D. C., who responded as follows:

"The raspberry root gall, I think, is undoubtedly due to the eelworm present. We have found the disease quite common, the galls sometimes being very large and greatly weakening the plant."

May 15, 1896.

Galls of this Thompson type, one and one-half inches in diameter, are not infrequent. Specimens of that size occur upon the Snyder blackberry at the Station. The disease is without doubt widespread in Ohio. The Marlboro and Cuthbert raspberries at the Station are likewise affected similarly to the Gregg (Pl. III., 1). It is improbable that any variety is immune from the disease.

Diseased plants of the Thompson variety were transplanted, May 5th, in the Botanist's disease garden. Only 20 per cent. of these lived, and none with gall on at setting; but it must be admitted that such late transplanting is unfavorable as a rule.

REMEDIES FOR CROWN GALL.

There seems to be little hope of curing a plant with this disease. The most that can, at present, be suggested, is to remove the plants once affected and burn them. The destruction may prevent the rapid spread of the gall to other plants. This will apply to both blackberries and raspberries, as there seems to be no difference in the trouble on the two.

A further hint may be of value. Nearly all fruit trees seem to be susceptible to the same trouble. The planting of raspberries and blackberries in young orchards is, therefore, a very dangerous practice. The liability to infect the young trees with the crown gall trouble, if no other reason may be urged against the practice, seems to me sufficient to condemn such planting.

These gall troubles appear to me to be as serious as almost any other disease of fruit trees. Great care is needed to avoid infecting healthy trees or planting diseased stock.

The root gall disease of all fruits is being studied by the Station Botanist. Any notes or specimens that may add to the knowledge of this trouble will be most welcome.

III. DISEASES OF PLUM AND CHERRY.

The plum and cherry are nearly related species of plants and are accordingly susceptible to the attacks of the same species of parasitic fungi. This arises from the selective or other power possessed by these parasites. Nearly all species of parasitic fungi are limited to particular species of plants and those plants affected by them are called the hosts of the fungi in question.

There are several well known diseases of the plum and cherry, including the black knot, the rot, plum pockets, mildew, shot hole or leaf spot fungus, and scab. One of these, the black knot, has been treated of in Bulletin 72, but, for apparent good reason, will be again mentioned.

1. ROT OF PLUMS AND CHERRIES.

Nearly everyone is familiar with the rapid decay of the fruits of plum and cherry, so notable during the prevalence of moist, warm weather near the time of ripening (Fig. 3). This condition of excessive heat and moisture is favorable to the decay of the fruits, but is not the cause of the breaking down which we call rot. The cause is to be found in a species of fungus, the rot fungus, (*Monilia fructigena* Pers.), which develops rapidly under the conditions just referred to. For the commercial plum grower, there is no other disease that will probably give the trouble and cause the losses that will come from the rot fungus. Its spread is somewhat dependent upon the crowding of the fruits, but, after all, is more a matter of conditions favorable to the growth of the fungus than of any other single factor. And it would appear that whenever we have a continuance of hot, rainy weather, as the plums or cherries approach maturity, we may expect the inroads of the rot.

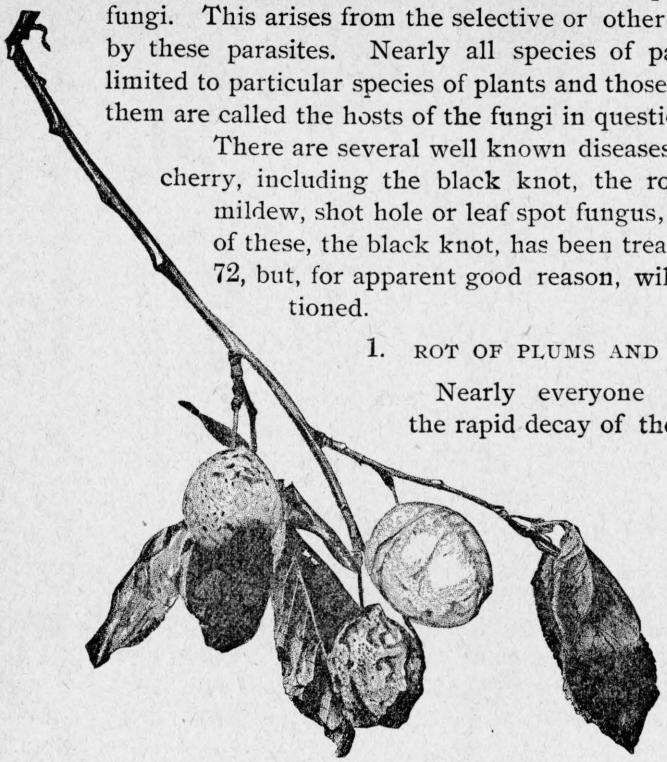


FIG. 3. ROT OF PLUMS (After Weed).

For practical purposes, we are justified in concluding that the rot fungus passes the winter chiefly in the rotted, dry, "mummy" fruits that often hang on the trees over winter, or may lie upon the ground where they have dropped in picking. Those upon the trees are evidently nearest the line of battle and will bear closest watching. Dr. Smith[1] has

[1] Journal of Mycology, VII., 37–8.

shown that during April rains the fungus may start into growth in the old, mummy peach fruits, and result in infecting the peach twigs, through the blossoms, causing a serious twig blight in eastern orchards. Whether the same appears to any extent with plums, I am unable to state. But the first condition of successful prevention of rot in these fruits *is the thorough removal of all the old mummies each year before the warm spring weather comes.* If they are permitted to remain on the trees over winter, they should be gathered and burned. If, however, the rotted fruit is removed at the time of picking, it will probably be disposed of by the subsequent cultivation of the orchard. The removal of rotted fruit as it appears upon the trees will sometimes save what remains. This is an expensive practice and may be beyond the reach of the large grower.

That fungicides may be used to prevent the rot of plums, in a measure, seems probable, but we may not infer that complete prevention is likely to be attained. The best fungicide for this purpose is Bordeaux mixture, which may be used of standard strength upon plum trees. In dealing with the rot fungus it is advisable to make a first application before the blossoms open. Later applications may be made with reference to the growth of the fruit. Where spraying with arsenites is practiced, the Bordeaux mixture makes a suitable vehicle for the application of the Paris green.

A small field experiment in spraying for rot was undertaken at Gypsum, in 1896. The treatment was continued until about the middle of June, when it was suspended. Mr. Miller, in whose orchard the spraying was done, reported the appearance of rot upon the untreated check trees, two to three weeks before it appeared upon the treated. This partial success is given for what it may be worth to those interested. It would appear possible to continue the spraying up to within two or three weeks of ripening. In that case, it might be advisable to use ammoniacal solution of copper carbonate for the last one or two sprayings.

NOTE—The following are Professor Green's directions and suggestions concerning this fungicide. (Bulletin 48, Ohio Experiment Station, page 5.)

Ammoniacal solution of copper carbonate:

Copper carbonate, 6 ounces.
Ammonia, 3 pints.
Water, 50 gallons.

Dissolve the copper carbonate in the ammonia and add the water.

Caution—Use no more ammonia than is required to dissolve the copper carbonate. Ammonia is variable in strength, and the amount required must be tested in practice.

To make copper carbonate at a cost of one-third the usual price:

Dissolve 10 pounds of copper sulfate (blue vitriol) in ten gallons of hot water, also 12 pounds carbonate of soda in the same quantity of water. After cooling, mix the two solutions and stir well. Allow the mixture to stand twenty-four hours and settle, after which pour off the liquid. Add the same quantity of water as before, stir and allow to stand the same length of time. Repeat the operation again, after which drain and dry the blue powder, which is copper carbonate.

OHIO AGRICULTURAL EXPERIMENT STATION.

SUPPLEMENT TO BULLETIN 79.

SPRAY CALENDAR.

PREPARED BY W. J. GREEN, A. D. SELBY AND F. M. WEBSTER.

This Calendar is designed to cover the needs of Orchardists and Gardeners. It was first prepared at the request of the Ohio State Horticultural Society. Insecticides and Fungicides may often be combined. Where Bordeaux mixture is used for fungous diseases this practice is recommended. Spraying young orchards with Bordeaux mixture from time of planting and of stocks in nursery row, is strongly recommended to preserve healthy conditions.

What to Spray.	For what to Spray.	With What to Spray.	When to do Spraying.				Remarks and Cautions.
			First Spraying.	Second Spraying.	Third Spraying.	Fourth Spraying.	
Apple	Bitter rot	Ammoniacal cop. carb.	With first appearance of rot	Two weeks after first	Two weeks later	Not required if Bord. prceedes	These follow Bord. for scab; danger on fair skin'd apples.
	Scab	Bordeaux mixture I	As buds are swelling	Just before blossoms open	Just after blossoms drop	7 to 10 days later	
	Sooty fungus	Bordeaux I	After blossoms drop	Two weeks later	These coincide with 3d and	4th for scab.	
	Bud moth	Arsenites in Bordeaux	With opening of buds				White skin'd apples are injured by spraying after 3d.
	Canker worm	Arsenites alone, 7 or 8	With first young worms	In 1 week if worms remain	Same as second		
	Codlin moth	Arsenites in Bordeaux I	After blossoms fall	7 to 10 days later	These coincide with 3d and	4th for scab	
	San José scale	Whale oil soap solution	As soon as leaves drop in fall	Just before fol. starts in Spr			1½ to 2 lbs. soap dissolved in 1 gallon water.
	Woolly aphis	Kerosene emulsion	When trees are not in full leaf	In fall			Don't use emul. in full leaf.
Bean	Anthracnose	Bordeaux I	Soak seed 1 to 2 h. in am. cop. car. five times strength of 3	Bord. on 2 to 3 in. plants	Bordeaux 10 days later	After blossoms	Repeat if needed.
Beet	Leaf spot	Bordeaux I	When plants are 5-6 in. high	Two weeks after first	Two weeks later		
Cabbage	Cabbage worm	Pyrethrum	With first appearance of worms	Whenever worms observed			
Cherry Stocks	Leaf spot	Bordeaux II	When leaves are half grown	Two weeks later	Two weeks later	About two weeks later.	
Cherry	Leaf spot	Bordeaux II	When leaves are unfolding	Two weeks later	2 or 3 weeks after second		First after blossoming.
	Rot (?)	Bordeaux I and II	Before blossoming I	After bloss. drop II, on fruit	Two weeks later II on fruit	Two weeks later II or 3	Use 3 when fruit is large.
	Aphis	Kerosene emulsion	On first appearance of aphis				Difficult to reach aphis.
	Cherry slug	Arsenites in Bord. II	When slugs appear	Repeat if slugs remain			Air slaked lime may be used.
	Curculio	Arsenites in Bord. I and II	Before blossoming in I	As blossoms dry up in II	One week later in II		Avoid strong solutions.
	San José scale	Whale oil soap solution	In fall as with the apple	As with the apple			
Cucumber	Anthracnose	Bordeaux I	When plants begin to vine	Two weeks later	Two weeks after second	Two weeks after third	Cover fruit and leaves.
	Spot of fruit	Bordeaux I	After first blossoms	Two weeks later	Two weeks after secon d	Two weeks after third	Apply to fruit carefully.
Currant	Leaf spot	Bordeaux I	As leaves are unfolding	Two weeks later	Two weeks later	2 or 3 weeks later	This trou. is diff. to prevent.
	Plant bug	Kerosene emulsion	May	Early June if necessary			
	San Jose' scale	Whale oil soap solution	As with the apple	In spring as with apple			
	Worm	White hellebore	When worms first appear	In 3 or 4 days repeat	Repeat as second.		
Gooseberry	Leaf spot	Bordeaux I	As currants with leaf spot	As currants with leaf spots	As currants with leaf spot	As currants with leaf spot	
	Mildew	Bordeaux I or 5	Before leaves open I	After blossoming I	Potass. sulfid 2 weeks later		Bord. coats fruit if used for 3d.
	Worm	White hellebore	As on currants.				
Grape	Anthracnose	Bordeaux I	Just before buds open	Just before blossoming	Just after fruit has set	10 days later, Bordeaux	Don't spray after fruit is half grown.
	Downey and powdery mildew	Bordeaux I	Just before blossoming	After fruit has set	10–14 days later		Covered by spraying for anthracnose or rot.
	Rot	Bordeaux I and 3	Just before buds open	Just before blossoming	Just after fruit has set	10 days later, Bordeaux	Follow by 2 or 3 sprayings with am. cop. carb. Don't spray after fruit is half grown.
	Leaf hopper	Kerosene emulsion	Before young can fly				
Muskmelon	Leaf blight	Bordeaux I	When plants begin to vine	Three weeks later	Three weeks after second	Two weeks after third.	
Peach	Leaf curl	Bordeaux I and II or copper sulfate	As buds are swelling, Bord. I or cop. sul. sol	Just after cal. drops Bord. II	Later not required		Second even probably not.
	Pustular spot	Bordeaux II	Just after calyx drops	Two weeks after first	Two weeks later		Cover fruit well.
	Rot (?)	Bordeaux I and II	As buds are swelling I	Just after calyx drops, II	3 to 4 weeks later II	As fruit begins to color II	Every 7-10 days repeat.
	Scab	Bord. I or cop. sul. sol	As buds are swel. Bord. I or 4	As for curl Bordeaux II	Two weeks later Bord II	Two weeks later Bordeaux II	
	Bud moth	Arsenites in Bord. I	With opening of buds				Use only ½ usual amount of poison.
	San Jose' scale	Whale oil soap solution	As soon as leaves drop in fall	Just before fol. starts in spring			
Pear Stocks	Leaf spot or blight	Bordeaux I	When leaves are half grown	Two weeks later	Two weeks later	Two weeks later	5 to 7 sprayings are needed.
Pear	Leaf spot	Bordeaux I and 3	When leaves are half grown	Two weeks later	Two weeks after second	Bord. may make russet fruit	Use 3 for 3d; not Bord. after 2d.
	Scab	Bordeaux I	Before blossoms open	After blossoms drop			Bordeaux after second may injure fruit.
	Bud moth	Arsenites in Bord. I	With opening of buds				
	Canker worm	Arsenites in Bord. I	As with the apple				
	Codlin moth	Arsenites in Bord. I	After blossoms fall	7 to 10 days later			
	San Jose' scale	Whale oil soap solution	As soon as leaves drop in fall	Just before fol. starts in spring			1½ to 2 lbs. soap dissolved in 1 gallon water.
	Slug	Arsenites in Bord. I	When slugs appear	Repeat if slugs remain			
Pea	Mildew	Bordeaux I	When mildew appears	Two weeks later			
Plum	Rot (?)	Bordeaux I, also 3	As buds are swelling I	Just after calyx drops I	3 or 4 weeks later I	As fruit begins to col. use 3	Every 7-10 days repeat, 4th; useless to spray for rot, unless mummies are destroyed.
	Shot hole fungus	Bordeaux I	When leaves are half grown	Three weeks later	Three weeks later, if needed		
	Curculio	Arsenites in Bord. I	With starting of buds	Just after calyx drops	5 days later		Jar and gather stung plums in addition.
Potato	Early blight	Bordeaux I	When plants are 6 in. high	Two weeks later	Two weeks later	Two weeks later.	
	Late blight	Bordeaux I	As for early blight in all				
	Blister beetle	Bordeaux I	When beetles appear	Repeat if necessary			
	Colorado beetle	Arsenites alone or in Bord. I	When beetles or young appear	As for first	As for first and second		
	Flea beetle	Bordeaux I	When beetles appear	Repeat if necessary			
Quince Stocks	Leaf spot	Bordeaux I	When leaves are half grown	About two weeks later	Two weeks later	Two weeks later	Perhaps 5th spraying will be needed.
Quince	Leaf spot	Bordeaux I	As buds are swelling	When leaves are half grown	Two weeks later	Two weeks later	Second should come after blossoms drop.
	Fruit and leaf spot	Bordeaux I	Before blossoms open	After blossoms drop	Two weeks after second	Two weeks later.	
Raspberry and Blackberry	Anthracnose	Bordeaux I and II	Before leaves open use I	II on young canes 6 in. high	Repeat second one week later		Keep spray from leaves on bearing canes.
	Leaf spot on Dewberry	Bordeaux I	When leaves are half grown	Two weeks later	Two weeks later		
	Saw fly	Pyrethrum or hellebore	As for currant worm	In 3 or 4 days repeat			
Tomato	Anthrac n ose	Bordeaux I	Soon after fruit begins to set	Three weeks later	Three weeks later.		
	Leaf blight	Bordeaux I	Three weeks after transplanting	Three weeks after first	Three weeks later	Three weeks later.	
Watermelon	Anthracnose	Bordeaux I	When plants begin to vine	Three weeks after first	Two weeks later	Three weeks later.	

FUNGICIDES.

1.
Bordeaux Mixture I.

Copper sulfate (blue vitriol) 4 pounds.
Quicklime (not air slaked) 4 pounds.
Water, to make 50 gallons.

Dissolve the copper sulfate in about two gallons of hot water, contained in a wooden vessel, by stirring, or even better, by suspending the sulfate contained in a cheese cloth sack, in a large bucketful of cold water. With the cold water and cheese cloth bag, a longer time is required. Pour the sulfate solution into the barrel or tank used for spraying, and fill one-third to one-half full of water. Slake the lime by addition of a small quantity of water, and when slaked cover freely with water and stir. Pour the milk of lime thus made into the copper sulfate, straining it through a brass wire strainer of about 30 meshes to the inch. Pour more water over the remaining lime, stir and pour into the other; repeat this operation until all the lime but stone lumps or sand is taken up in the milk of lime. Now add water to make 50 gallons in the tank. After thorough agitation the mixture is ready to apply. The mixture must be made fresh before using, and any left over for a time, should be thrown out or fresh lime added.

2.
Bordeaux Mixture II.

Copper sulfate, 2 pounds.
Quicklime, 2 pounds.
Water, to make 50 gallons.

For use on such trees as have foliage injured by Bordeaux I.

STOCK SOLUTION.

A solution of copper sulfate containing say one pound of sulfate to the gallon of water may be made up and permitted to stand indefinitely in a covered barrel if no lime is added. Such a solution is known as a stock solution and two or four gallons of this stock solution according to the strength desired, are taken for each 50 gallons of mixture to be made. For extensive spraying, a long trough or box of uniform width may be used in which to slake and keep the lime. The quick lime is weighed out according to the amount needed immediately, placed in the trough and slaked with a small quantity of water. The whole is evenly spread and covered as a putty, with water to exclude the air. This putty may be removed in calculated portions, placed in a tub and treated like the freshly slaked lime. By means of stock solution of copper sulfate and the lime in putty state, much valuable time is saved in filling the barrels or tanks used in spraying.

3.
Ammoniacal Solution of Copper Carbonate.

Copper carbonate, 6 ounces.
Ammonia, about 3 pints.
Water, 50 gallons.

Dissolve the copper carbonate in the ammonia and add the water.

Caution: Use no more ammonia than is required to dissolve the copper carbonate. Ammonia is variable in strength, and the amount required must be tested in practice.

To make copper carbonate: Dissolve 10 pounds copper sulfate (blue vitriol) in 10 gallons of water, also 12 pounds carbonate of soda in same quantity of water. When cool, mix the two solutions slowly, stirring well. Allow the mixture to stand twelve hours and settle, after which pour off the liquid. Add the same quantity of water as before, stir and allow to stand the same length of time. Repeat the operation again, after which drain and dry the blue powder, which is copper carbonate.

4.
Copper Sulfate Solution.

Copper sulfate, 4 pounds.
Water, to make 50 gallons.

Dissolve the sulfate as directed for Bordeaux I.

Caution: This solution will injure foliage. It can be used only before the buds open.

5.
Potassium Sulfid Solution.

Potassium sulfid (liver of sulfur) 1 ounce.
Water, 3 to 4 gallons.

This solution will not remain unchanged. The potassium sulfid must be kept in a well stoppered bottle.

INSECTICIDES.

6.
Kerosene Emulsion,

Dissolve one-half pound hard soap in one gallon of water (preferably soft water) and while still boiling hot, remove from fire and add two gallons of kerosene. Stir the mixture violently by driving it through a force pump back into the vessel, until it becomes a creamy mass that will not separate. This requires usually from five to ten minutes. The emulsion is then ready to be diluted with water and applied. For the common scale insects and hard bodied insects like the chinch bug, use 1 part emulsion to 8 or 10 parts water. For soft bodied insects (plant lice, etc.) use 1 part emulsion to 15 to 20 parts water.

Kerosene emulsion kills by *contact* and therefore the application should be very thorough. It may be used against a great many different pests, but is especially valuable for destroying those with sucking mouth-parts, for they cannot be killed with arsenical poison.

7.
Paris Green.

In combination with Bordeaux mixture, Paris green may be used at the rate of 1 pound to 175 to 200 gallons.

When Bordeaux mixture is unnecessary, the Paris green may be used at the same rate, but 2 or 3 pounds of freshly slaked lime must be added to prevent burning of the foliage. Keep the mixture well stirred so that the poison will be distributed evenly.

In cases where successive sprayings are necessary, it is important to consider the accumulation of poison and use a slightly weaker mixture unless sufficient rain has fallen to wash off the poison thoroughly.

8.
London Purple.

If desirable London purple may be substituted for Paris green, but it has the disadvantage of being somewhat variable in composition and contains more soluble acid. For that reason it must be used somewhat weaker, or else an abundance of lime provided, so as to prevent burning of the foliage. It has the advantage of not settling as readily as Paris green.

9.
White Hellebore.

Hellebore is often employed in cases where arsenical poisons would be objectionable. Use one ounce to three gallons of water.

10.
Pyrethrum.

Pyrethrum is usually applied with a bellows but may be used as a spray at the rate of one ounce to two gallons of water.

11.
Whale Oil Soap Solution.

Use from one to two pounds of the soap to one gallon of water. Be sure that the soap is thoroughly dissolved, and then apply in form of spray.

This page intentionally blank.

Fig. 1.

Fig. 2.

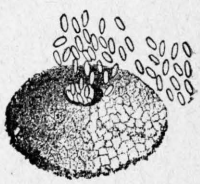


Fig. 4.

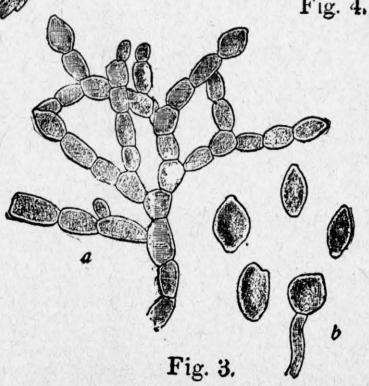


Fig. 3.

L. Detmers, del.

PLATE IV—PLUM POCKETS.

2. PLUM POCKETS.

Green fruit upon plum trees sometimes appears swollen, distorted and bladdery. This commonly occurs in June, and is, perhaps, more frequent upon wild species than upon the cultivated sorts. It has been occasionally reported upon the Miner variety. Such bladder plums when cut open are found to be hollow and without stone. This swelling and distortion is a diseased condition due to the plum pocket fungus (*Exoascus pruni* Fckl.) All the affected fruits drop off and are, therefore, a loss. The same fungus attacks the twigs of American sorts of both Americana and Chicasa types. With the affected twigs, the resemblance of the trouble to the leaf curl on peaches is very striking. Indeed, the fungi of leaf curl and plum pockets are very closely related species. Miss Detmers[8] has described and figured the excrescences upon twigs of *Prunus Americana*.

Through the kindness of Mr. J. S. Hine, Secretary of the Columbus Horticultural Society, I am enabled to print herewith Miss Detmers' illustration (Pl. IV). The same affection upon *Prunus Chicasa* has been sent me from Clyde, Ohio. Scribner[9] makes the following statements:

"The mycelium of the fungus is found in the smaller branches in early spring before the diseased fruit appears, which seems to indicate that it may live from year to year in the tree itself; moreover, the annual recurrence of the 'pockets' on the same tree furnishes additional proof of this fact.

"The only course of treatment which a knowledge of the facts in the case suggests is to remove and destroy the 'pockets' before they reach maturity. In doing this, it would seem to be well to cut back the branches so as to destroy all the parts which are likely to contain the mycelium of the fungus. Instances have come under our observation where this practice was followed for two or three years with decidedly beneficial results."

This suggestion refers to the affection of the fruits. The same observation would apply to the pockets on twigs. The success attained by the writer in the prevention of peach leaf curl, indicates that the pockets on both fruit and twig may be prevented by the use of Bordeaux mixture, or by a solution of copper sulfate, applied with a spray pump just before the blossoms open. The injuries from plum pockets do not appear to have been very great and probably only occasional trees will be found infected by the fungus.

---

[8] Journal Columbus Horticultural Society, VI, 113, 1891.

[9] Report U. S., Dept. Agric., 1888, 369.

EXPLANATION OF PLATE IV.

Fig. 1 shows twig of *Prunis Americana* attacked by the fungus, *Exoascus pruni*. Fig. 2 shows spore, (*asci*) of the fungus. Figs. 3*a* and *b*, hyphæ and spores of the rot fungus found in the "pocket." Fig. 4, Pycnidium of another fungus, *Phyllosticta*, found also on the branch.

3. SCAB.

The scab fungus, (*Cladosporium carpophilum* Thüm.) so conspicuous upon peaches in wet seasons, also affects plums. It appears as black spots upon the skin of the fruit. The affected parts remain hard and do not ripen properly, especially when half of the fruit is affected. Professor Taft[10] reports the De Soto plum as particularly subject to the scab.

From the results obtained by the writer in spraying peaches for scab, it is probable that the disease may be prevented upon plums by the use of Bordeaux mixture.

4. BLACK-KNOT.

This contagious disease has already been treated of in Bulletin 72. A full account may be found in that bulletin. It is a fungous disease, due to the black-knot fungus, (*Plowrightia morbosa* Schw.). It attacks all species of plums and cherries, both wild and cultivated. It does not, so far as we know, attack peach, apple, cottonwood, oak, hickory, blackberry or raspberry. (The excrescences on these plants and trees are frequently mistaken for black-knot.) Plate V. will show the characters of the fungus and the appearance of the knots at different seasons of the year. Black-knot is contagious and is spread by the spores; in summer by the summer spores, (Fig. 3.) and is carried over winter by the ascospores formed in the external portions of the knots. These are shown in figures 4 and 5. The winter spores (ascopores) do not develop until late in winter and are distributed by the bursting of the spore cases (perithecia) in early spring. Black-knot is, therefore, easily prevented by the careful removal and burning each winter of all of the knots on the affected trees. The knots may be observed early in the summer. Figure 1 of the plate shows a knot gathered May 16. It is a good practice to remove the knots at any time and destroy them, but if the spread of the knots is prevented it is necessary that clean work be done every fall or winter. The law makes this obligatory upon any person occupying grounds where affected plum or cherry trees grow, and it is the duty of the township Board of Fruit Commissioners to look after the execution of this statute.

---

[10]Taft, L. R., Bulletin Michigan Experiment Station, 103, p. 57.

EXPLANATION OF PLATE V.

Fig. 1. A forming knot on cherry twig, taken May 16, two-thirds natural size.
Fig. 2. A mature knot extending into a fork, two-thirds natural size.
Fig. 3. Summer spores (*conidia*); a section from twig of Fig. 1 magnified 130 diameters.
Fig. 4. Section through a spore case (*perithecium*) showing spore sacs (*asci*).
Fig. 5. Asci containing winter spores or ascospores, x130.
Fig. 6. Spermogonia.
Figs. 1, 2, 3, 5, original drawings. Figs. 4 and 6, after Farlow.

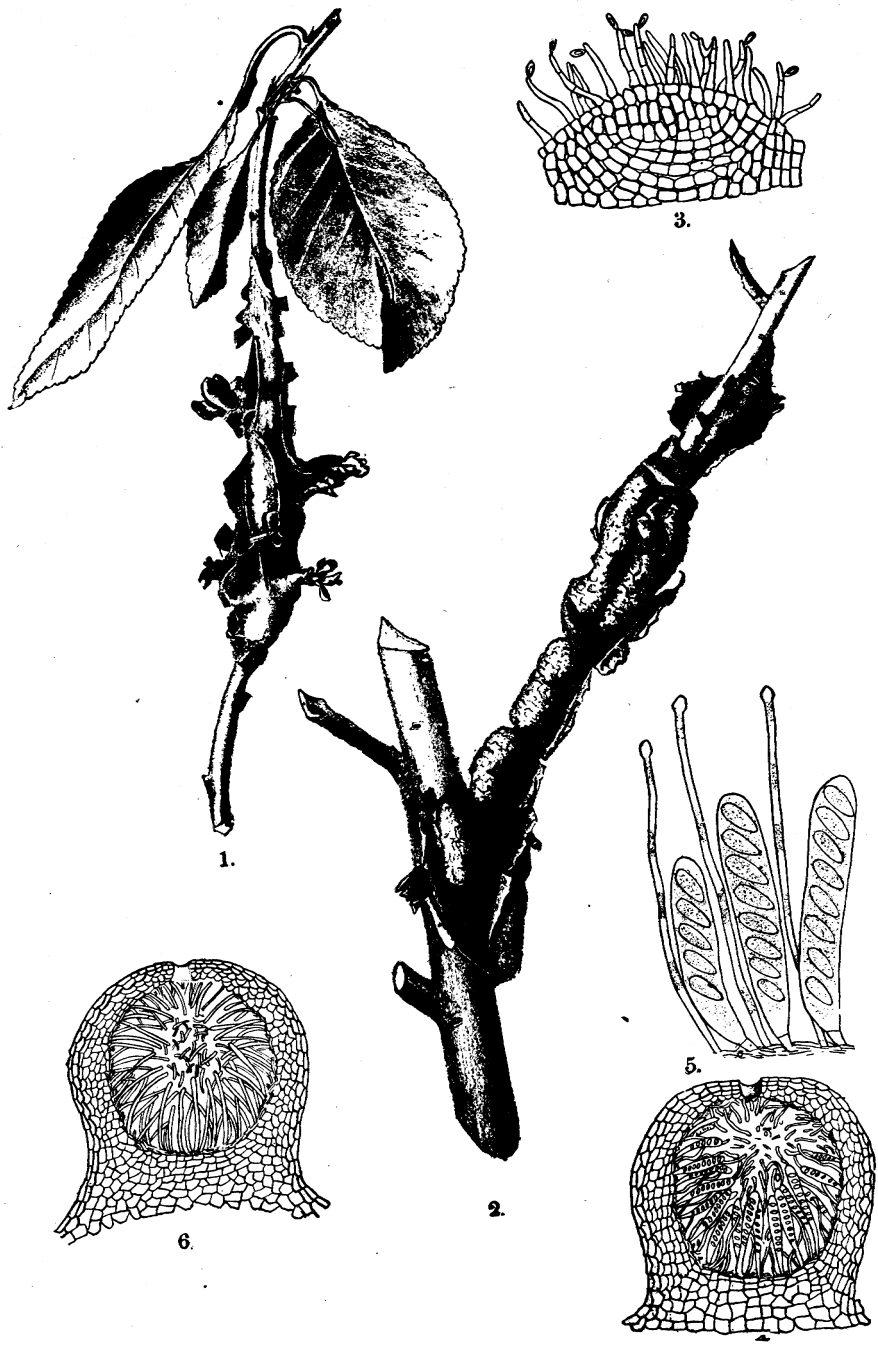


PLATE V.—BLACK-KNOT OF CHERRY (*Plowrightia mobosa*).

This page intentionally blank.

5. A TWIG DISEASE WITH GUM-FLOW.

Plum trees in many parts of the State are affected with a peculiar disease of the twigs and branches. This disease apparently begins in the region of the buds on the first year's growth (1, Fig. 4). The bud is destroyed and a small dead area formed in the axil or at the side of the leaf scar. This wounding, whatever be the cause, and indeed, wounds from any cause, result in the flow of gum. For this reason the disease has been called *gummosis of the plum*, but apparently the gummy condition is a result of the real disease and not the disease itself. In the growths of the second and third years and even on older branches, there is copious exudation of gum, (2, Fig. 4). This condition will probably shorten the life of affected trees. A similar diseased condition of the peach prevails in Ohio and is widely scattered. These troubles of both peach and plum are now being studied and no explanation of the cause can, as yet, be assigned. Whether or not the fungicidal treatment recommended for some diseases will have any effect, cannot be stated. Similar conditions of these and other plants, in Europe, have been, by the various authors, assigned to different causes; for example bacterial gum disease (*La Gommose bacillaire des vignes*. Prilleux et Delacroix) and gum-flow (*Gummifluss der Steinobstbaume*. A. B. Frank)[11].

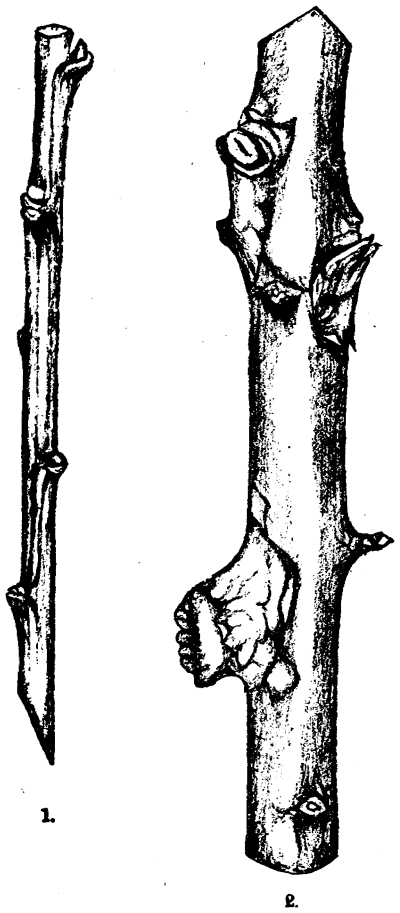


Fig. 4. TWIG DISEASE OF PLUM WITH GUM-FLOW.

1. Shows disease of buds in first year's growth.

2. Is drawing of three-year old branch with copious exudations of gum. Both natural size. (Original.)

If we can ascertain the cause of the injuries noted and shown (1, Fig. 4.), the explanation of the gum-flow will follow. We may look for some organism or to unfavorable root conditions in explanation. Contributions of specimens of this trouble in both plum and peach will be thankfully

[11] Kraukheiten der Pflanzen I, 51, 1895.

received. The only remedial suggestions occur at present, are to prune the diseased branches as closely as practicable and to try spraying with Bordeaux mixture. This being but a mere report of the occurrence of the trouble, statements herein made are not to be taken as final.

6. SHOT-HOLE FUNGUS OF PLUM—LEAF SPOT OF CHERRY.

From the middle of June to the end of the season, the leaves upon plum trees are frequently badly spotted with a fungus, and the dead spots caused by it afterwards fall out. This gives the shot-hole or perforated effect often spoken of, (Fig 5). This figure also shows spores of the fungus. The affected leaves soon drop off and complete defoliation of the trees may occur. Similarly, the leaves of cherries are spotted, but,

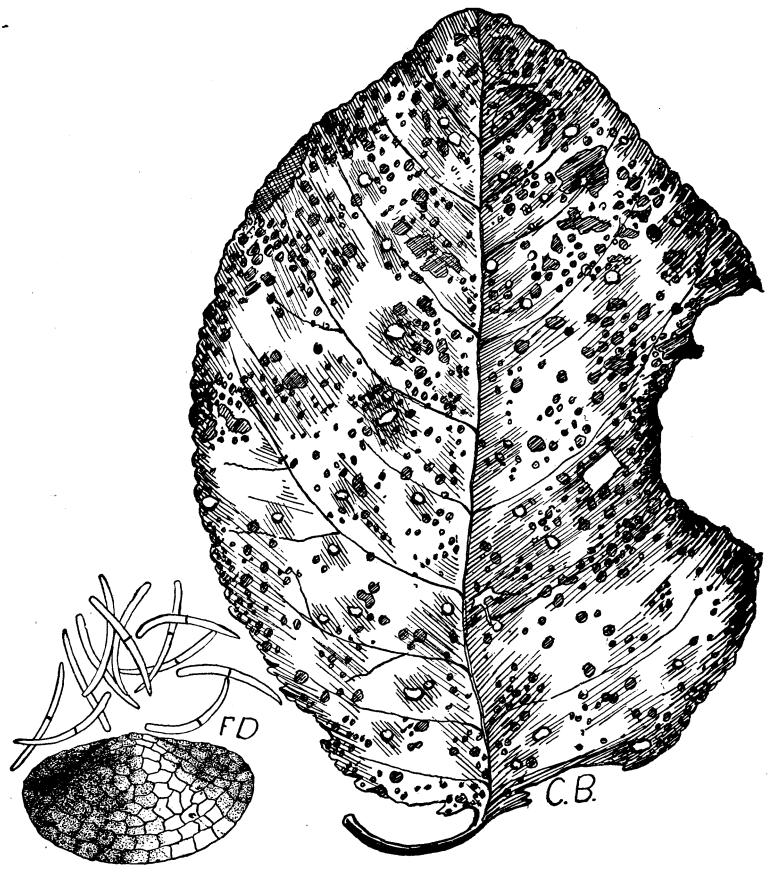


FIG. 5.—SHOT-HOLE FUNGUS OF PLUM.

Diseased leaf, natural size. Spores, magnified 300 diameters. (The other figure shows cover of an acervulus or spore-bearing spot.) (Original.)

in this case, the dead areas do not so commonly fall out and there is less appearance of perforation in the leaves, (Fig. 6). These leaf troubles of both the plum and cherry are, so far as studied, due to the same fungus — *Cylindrosporium padi* Karst. (Fig. 5.) Whether we call this the "shot-hole fungus" or the "leaf spot fungus" is a matter of slight importance, so that we remember the cause is the same in both. Many plum orchards suffered severely from the shot-hole fungus in 1896. Trees were observed in August, completely stripped of leaves and where the defoliation had taken place some little time before, new leaves, were putting forth and blossoms, were opening. The disease seems to be general upon the plum, although it is more noticeable in those districts where most plums are grown. When the leaves drop before the fruit has ripened, the fruit fails to mature, and, in any case, the early dropping of the leaves, followed by new foliage and blossoms, will interfere with the subsequent crop. We thus see that the shot-hole fungus of the plum will not only prevent the crop of fruit from ripening but may cut off the next year's crop to a certain extent. This arises, in part, from failure to form good fruit buds, and in case these fruit buds open during the season in which they are formed, there will not be fruit buds for the spring blossoming. In the case of cherries, the defoliation has, so far as observed, been less complete and the injury correspondingly less, but on cherry trees as well as on plums, it does not appear that the trees will get well of themselves. Wherever the Cylindrosporium affects plums and cherries very greatly, it will be necessary to resort to fungicides for its prevention. This Cylindrosporium is frequently very bad on nursery stocks, especially on cherries.

FIG. 6. LEAF SPOT OF CHERRY.
Diseased leaf, natural size. (Original.)

PREVENTION OF SHOT-HOLE FUNGUS AND LEAF SPOT.

It has been shown by this Station[12] that the shot-hole fungus can be effectually prevented by spraying with Bordeaux mixture. It was further noted that Paris green used alone aggravates the trouble.

Fairchild[13] has shown the favorable effect of Bordeaux mixture used upon nursery stocks affected with Cylindrosporium. There seems no doubt as to the effectiveness of this remedy for these leaf troubles. The number of applications required has not been determined by this Station. Apparently, two or three applications will be needed to prevent all, or nearly all, of the disease. However, one application will be beneficial. The first application should be made when the leaves are fairly out, and the subsequent sprayings as indicated in the calendar. Where the defoliation has been severe, it seems advisable to make at least three applications.

7. MILDEW.

The powdery mildew (*Podosphæra Oxyacanthæ* DBy.), prevails to a limited extent upon plum and cherry trees. It may be known by the mildewed appearance of the leaves due to the presence of the fungus. Interspersed among the webby covering occur the small dark pin-head like bodies, the spore cases of this mildew. The damage from mildew upon bearing trees is not often very great; upon nursery stock the case is frequently different. The mildew may be prevented by the use of Bordeaux mixture. Directions for application are the same as for shot-hole fungus.

---

[12]Green, W. J., Bulletin, IV., 9, 216.
[13]Journal of Mycology, VII., 249–255.

IV. PEAR AND QUINCE TROUBLES.

1. BLIGHT

The first blight of branches of the pear and quince has been prevalent wherever these fruits are grown in this state. This disease ranks as one of the most destructive known to the orchardist. The twigs and large branches and even the trunks of the pear and quince are attacked by the blight, while the twigs of the apple have suffered severely in Ohio during the last two seasons. According to Waite,[14] every tree of the pome family, including Siberian crab apple, wild crab apple, mountain ash, service berry, and all the species of Cratægus or hawthorns are affected by the same disease. Reference has already been made to the blight of raspberry assigned to the same cause.

From the discovery of Dr. Burrill and the subsequent investigations of Arthur, we learn that this blight is caused by a microbe or bacterium (*Bacillus amylovorous*). That these microbes are the cause of the disease, there seems no reasonable doubt. The microbes are found in freshly blighted twigs and may be cultivated in the laboratory and inoculations from the pure cultures thus obtained will produce the blight when introduced into a previously healthy tree. It appears that the trees are infected by the bacterium through the agency of bees, wasps, and flies which visit the blossoms. The infection is obtained from the exuded gum upon the blighted wood of the previous year. After flowers are once infected, the microbes may be carried to others from these as well. Insects probably carry the blight to the tender tips of shoots, in addition to the infection through the blossoms. The excellent article by Waite on "Cause and Prevention of Pear Blight in the year book of the Department of Agriculture, for 1895, will be accessible to most persons and is a most valuable article to every fruit grower. The most rapid growing varieties and most thrifty trees of pear and quince as well, appear most liable to the disease. The explanation for this is found in the greater tendency to produce a larger amount of new soft growth. Any treatment of the tree which tends to induce new growth favors pear blight. Among these may be named pruning, fertilizing, high manuring, and cultivating. It is not to be inferred that simply unpruned trees, or lean uncultivated land will be the most profitable, but within the conditions of the profitable bearing of trees, the suggestions are to apply. We know of no method for the prevention of pear blight in any of the trees susceptible to its attack. If the method of spread before stated—through the exuded gum on blighted wood of the previous year—be correct, then the source of infection may be removed, and this is the treatment recommended by Waite. The extermination of the blight will therefore, depend upon the extermination of the blight microbe:

---

[14] Waite, M. B., Cause and Prevention of Pear Blight, Year Book, U. S. Dept. Agr., 1895, page 299.

"This is to be secured by cutting out and burning every particle of blight when the trees are dormant." "Not a single case of active blight should be allowed to survive the winter within the orchard or a half mile of it. Every tree of the pome family including the apple, pear, quince, Siberian crab apple, wild crab apple, mountain ash, service berry, and all the species of the Cratægus or hawthorn, should be examined for this purpose, the blight being the same in all. The orchardist should not stop short of absolute destruction in every case, for a few overlooked may go a long way toward undoing all his work."

The blight may be cut out at any time during winter or spring, but the fall appears to be the best time for clean work. The leaves still remain on the blighted branches and the contrast between healthy and diseased parts is greater than at any other time. It is a good practice to cut out blight during the growing season. Care must be taken not to make this cutting out a means of infection. If the knife has been used in blighted wood, it should be sterilized before cutting into the healthy parts of the tree. The cutting should always be done far enough below the blighted wood to cut into healthy tissue. It will be seen that in the case of pear blight, as in the case of many other diseases, more depends upon thoroughness of the work than upon the mere cutting as suggested. The removal of ninety percent of the blighted wood may prove of very little benefit, while the removal of all of it may afford very satisfactory protection.

2. LEAF SPOT OF PEAR AND QUINCE.

The leaf spot or leaf blight of pear and quince has prevailed to a greater or less extent. The trouble called by this name is due to the leaf spot fungus, (*Entomosporium maculatum* Lév.) The same fungus also affects the fruit of the pear, often causing it to crack badly. It likewise causes spots on the fruit of the quinces. Nursery stock of both sorts is often badly affected by the leaf blight. This fungus is readily checked and its spread prevented by the use of Bordeaux mixture. The spraying should be conducted as suggested in the spray calendar.

3. PEAR SCAB.

This disease of the pear fruit has been observed occasionally, and may be distinguished on the fruit from the preceding by the scabbed appearance and the absence of the deep cracking caused by the leaf spot fungus. The pear scab fungus, (*Fusicladium pirinum*), is of the same genus as the apple scab fungus and may be prevented by the same treatment as that successfully used to prevent apple scab. A caution is needed to avoid injury to the pears from the spray.

4. ROOT OR CROWN GALL OF PEAR.

Gall-like enlargements upon the roots and stems of pear trees, similar to those already described upon raspberries, appear to occur with increasing frequency. They are often present upon the pear stocks imported from France. The illustration (Fig. 7) will indicate their appearance upon roots of three year old pear trees. In the example there were three upon the same tree. Upon the imported stocks for grafting the galls occur more frequently on the stem near the surface of the ground, and on the larger trees more commonly upon the roots. I believe it is the practice among nurserymen to burn the affected stocks when received. I am not sure that the practice of burning affected trees of several years' growth is by any means as general. From the information collected with respect to crown gall upon peaches it seems that we have in this to deal with a serious disease. On the Pacific slope,[15] crown gall is a serious trouble.

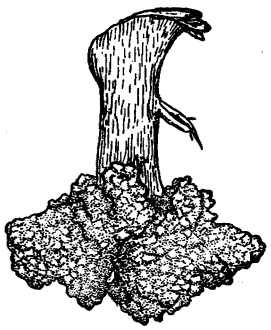


Fig. 7.
ROOT GALL ON PEAR
(Natural size.)

As yet, no successful remedy has been discovered. It is strongly urged to burn all nursery stock affected with this gall. The apparent increase of the disease warns us to use caution, and aside from the necessity of caution, it is extremely doubtful whether trees once affected will grow to profitable production.

5. BLACK ROT OF THE QUINCE.

There is a disease caused by the black rot fungus (*Sphæropsis malorum* Peck.) which produces spotting of the leaves and rotting of the green quince fruits. Young quinces spotted with this fungus were seen at many points and the disease no doubt occurs generally over Ohio. The dark pimples of the fungus may be observed on the rotted areas. The same fungus sometimes attacks the apple. It may be prevented by the use of fungicides.

6. OTHER DISEASES OF THE QUINCE—SPRAYING QUINCE TREES.

The quince rust may occur where quince trees are growing in the vicinity of cedar trees. The cedar apples, commonly observed, are one stage of the fungus which causes the rust of the quince and some other fruits. Obviously, the remedy for this will be the destruction of the affected cedar trees. Halsted has described other quince diseases as the "quince pale rot," the "ripe rot of quinces" and the "quince blotch."[16] These have not observed upon quinces in this state.

---

[15] Woodworth and Tuomey, loc. cit.

[16] Halsted, B. D., New Jersey Experiment Station, Bulletin 91.

It has been a matter of frequent remark that none of the fruits commonly grown are neglected with respect to the diseases which occur upon them as are the quince trees. Most farmers or fruit growers have but a few trees and these are expected to do with the smallest amount of attention. Everywhere, these trees show spotted and dead leaves, spotted and rotten fruits, the latter sometimes of more than one year's standing, and close examination is not needed to discover evidences of neglect. Very few of the diseases of the quince are difficult to prevent and there is no other fruit tree that will respond more satisfactorily to spraying with fungicides than the quince tree. The Bordeaux mixture is recommended for use in spraying the quince. Three to five applications according to circumstances will prove very beneficial.

V. APPLE DISEASES.

The apple, like the pear, quince, and other pomaceous fruits, suffers from fire blight. Commonly, the parts blighted are the small, blossom bearing, terminal twigs, the softer growths of the tree. The short fruit spurs do not appear to suffer so frequently. The injury to the trees is usually less marked than in the case of the quince and pear, but, as already pointed out, if blight is to be prevented, it is necessary to attend to thorough removal and destruction of all blighted parts of the apple trees as well as of the others. The blight microbe seems likewise responsible for dead spots on trunks and branches. The other diseases of the apple are somewhat more prominent than the blight.

I. APPLE SCAB.

This disease has been discussed in previous publications of this Station, [17], and the practicability of its prevention by spraying has been thoroughly established. Illustrations of apple scab, showing the detailed characters of the apple scab fungus, (*Fusicladium dentriticum* Fckl.) Plate VI, and also the effects on young fruits and upon the leaves, Plates VII and VIII, are here reproduced. One object in presenting the subject at this time is to call attention to the necessity of spraying to destroy the scab, even in seasons when there is not a crop of fruit. This fungus affects both the fruit and leaves, and, in the absence of the fruit, there will be no lack of development upon the leaves when conditions are favorable. In the numerous apple failures of the past, the apple scab fungus has played a large part, and, perhaps, at times, has been the chief cause of failure. The fungus, no doubt, received a serious check to its development during the two successive dry seasons of 1894 and 1895, but that the comparative freedom of apples in 1896 proves that this will continue, seems very doubtful. In all localities where examination was made last summer, the scab fungus was found in greater or less abundance, and it appears probable that a period of neglect in spraying would bring about conditions under which a profitable apple crop is impossible. Where the scab fungus is abundant, and a period of cool, moist weather succeeds the blossoming of the trees, the fungus attacks the fruit when it is quite small. Young apples spotted with the scab are shown in the illustration. The result of such conditions may be the dropping of all the fruit, even where a fair crop has been set. It is fair to conclude, from what has been observed in the past, that many times the apple scab fungus is the real cause, while lack of pollination or fecundation of the flowers is the assigned cause, for apple crop failure. Orchardists can, therefore, scarcely afford to permit the apple scab fungus to accumulate and develop, in the hope of securing profitable crops without spraying. The value of the first treatment before growth begins in spring should not be overlooked. Three sprayings with last just after blossoms drop, have proven effectual in preventing apple scab.

[17] Bulletin IV, 9,—See also B. 48 and B. 63.

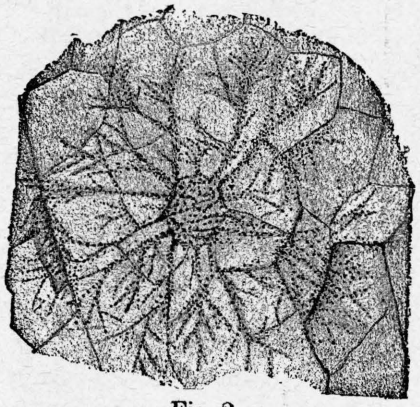


Fig. 2.

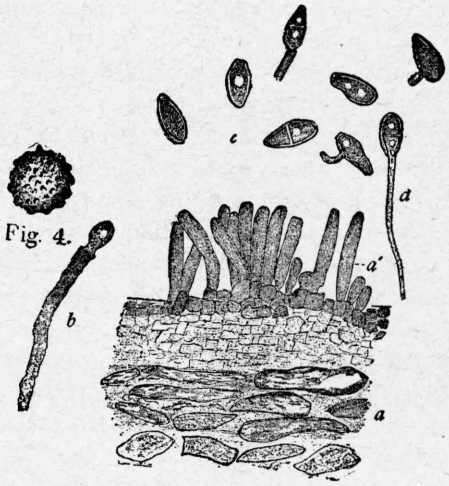


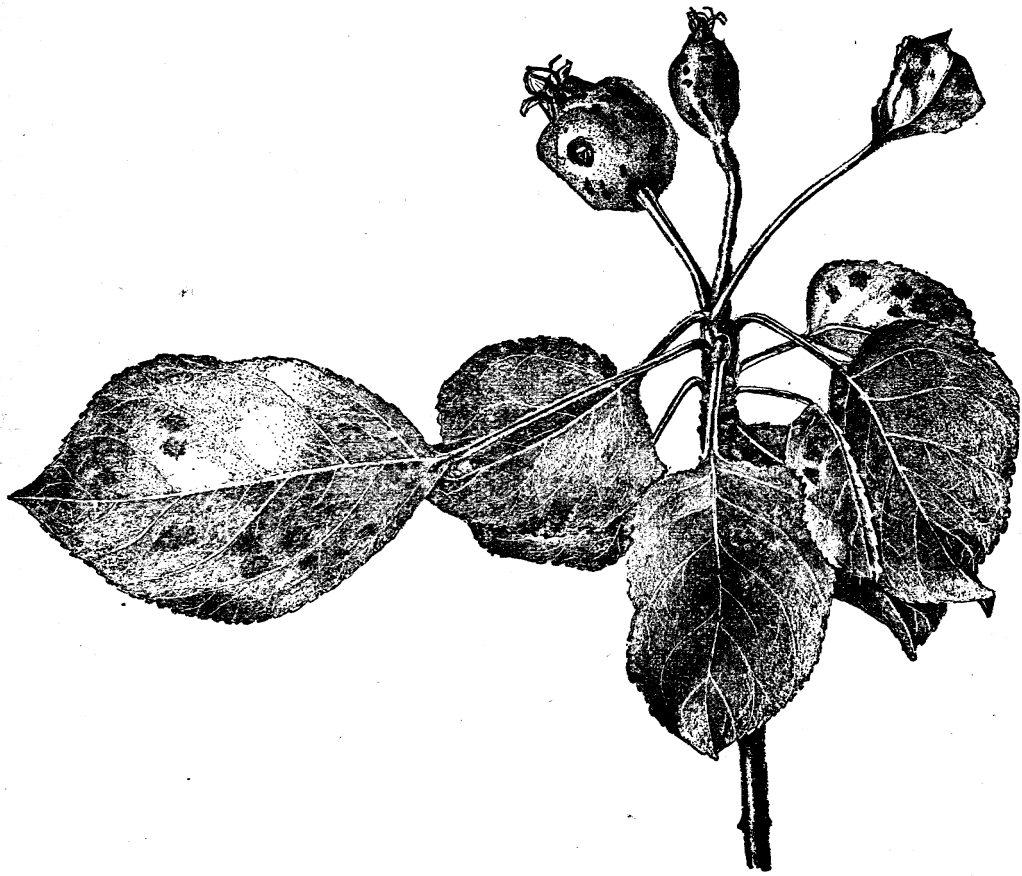
Fig. 4.

Detmers, del. Fig. 3.

Fig. 1.

PLATE VI.—APPLE SCAB FUNGUS AND ITS EFFECTS.

Fig. 1 shows an apple badly cracked with scab; At Fig. 3 is seen a section through a "scab" spot with hyphæ spores of the fungus; Fig. 2 shows the appearance of a scabby area on fruit or leaf when viewed with a good magnifying glass.



F. Detmers. del

PLATE VII—APPLE SCAB ON YOUNG FRUIT AND LEAVES.

This plate shows early spring appearance of affected fruit and leaves.

PLATE VIII—APPLE SCAB ON OLDER LEAVES.

Showing the appearance of scab-affected leaves in later summer. Such affected leaves are liable to drop early.

2. SOOTY FUNGUS AND FLY-SPECK FUNGUS—AN OLD ENEMY IN A WET SEASON.

The Station Horticulturist,[18], in earlier bulletins, has frequently referred to the sooty or black appearance upon apples and pears and its prevention where spraying for apple scab had been practiced.

In ordinary seasons, this sooty effect appears chiefly upon apples grown in low, moist situations. Pecks' pleasant, Rhode Island greening and Rome beauty are noted as affected by it. During the season of 1896, however, it prevailed upon fruit in all situations, and the disfiguring effect was most marked. The illustration, Fig. 8, will show the appearance of a fair skinned apple somewhat covered by the fungus, which seems to be responsible for this sooty effect. The figure shows two sorts of spots: A larger *sooty* spot apparently caused by a fungus mycelium which spreads over the whole of the discolored area, and a small *fly-speck* appearance, also of fungus origin. Both sorts of spots may occur upon the same specimen. Indeed, it is rare to find an apple affected with one that has not the other also. In both sorts, the fungus appears to be quite superficial, but evidently is parasitic in character. There is no apparent hardening of the skin or cracking of the apple as in the case of apple scab, but where the sooty and fly-speck fungus affects the fruits, the brightness is gone and the market value of the affected fruit impaired. Indeed, it would seem from some reports made, that the fungus may start and extend upon apples after they have been packed in barrels and stored. As yet, the writer's efforts to make cultures of the fungus, begun late in January, have not resulted favorably. The difficulty in getting growth in the culture tubes would lend doubt to the statements made as to the spread of the fungus on the apples after barreling.

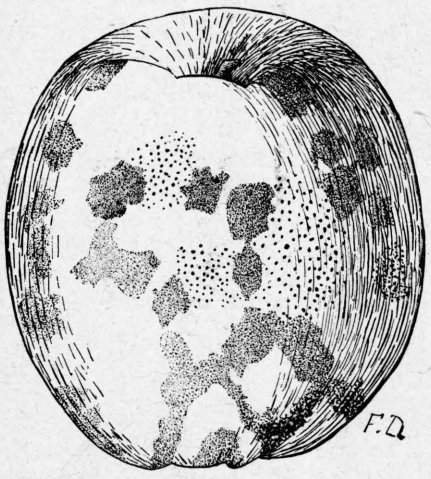


FIG. 8. SOOTY AND FLY-SPECK FUNGUS UPON APPLE.
Natural size, (Original)

Powell[19] refers the fly-speck fungus to *Leptothyrium pomi* (Mont. & Fr.). Halsted[20] illustrates the same thing by photograph and speaks of it as being a low form of fungus.

---

[18]Green, W. J., B. IV, 9. 200, 201, 211, 212: B. 48, 11; B. 63, 97, 101, 102.

[19] Powell, G. H., Garden and Forest, IX, 475, 1896.

[20]Halsted, B. D., Report of Botanist, New Jersey Experiment Station, 1893, 369.

In no instance was a spore case (pycnidium) of this fungus observed That spores are wanting for *Leptothyrium pomi* seems indicated by the reference in Saccardo's Sylloge.* Fig. 9, exhibits the ordinary mycelium of the sooty spots as well as the dense form of the fly-speck sort.

A single spraying with Bordeaux mixture, applied at the time the apples are the size of hickory nuts or larger, would prevent all or nearly all of this spotting. The spraying should be done earlier than stated upon Maiden's Blush, Grimes and Belmont to avoid russeting of fruit. This caution has a general application to fair skinned varieties of apples.

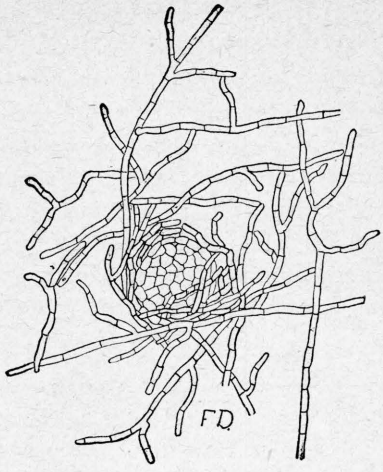


FIG. 9. FUNGUS OF SOOTY AND FLY-SPECK SPOTS.

3. BITTER ROT.

Several varieties of apples are affected with bitter rot, (Fig. 10). This is especially true of the "Bentley sweet," a favorite apple in Eastern Ohio. From the investigations of Alwood,[22] it is inferred that the Ohio trouble is due, like that he investigated, to the bitter rot fungus, (*Glœosporium fructigenum*, Berk.) Spraying with fungicides is recommended in Virginia orchards and appears to be worthy of trial in Ohio. The small, decayed spot, known as the bitter rot of the Baldwin, which occasionally appears on fine, large fruit of that variety, seems not to have the same cause. This is more properly a spot than a rot, but is generally called the "Baldwin bitter rot" in this state. Jones[23] has investigated this trouble and attributes it to a fungus (*Dothidea pomigena* Schw.) It is somewhat doubtful whether spraying will be of any benefit for it.

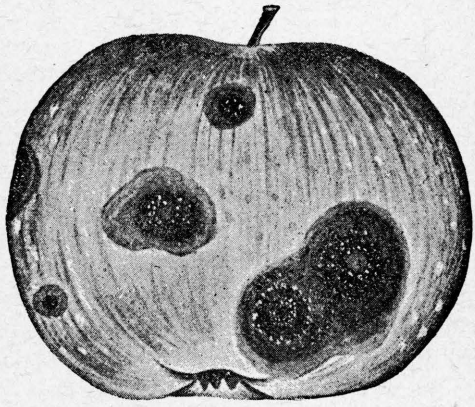


FIG. 10. BITTER ROT OF APPLE. (After Alwood).

Alwood[24] recommends the use of ammoniacal carbonate of copper,

*Sylloge Fungorum, III, 632.

[22]Alwood, W. B., Virginia Experiment Station, Bulletins 17 and 40.
[23]Jones, L. R., Rep. Vermont Experiment Station, 1891, page 133.
[24]Loc. cit. Bulletin 17, 65.

for the true bitter rot, since the disease does not appear until midsummer and late applications of Bordeaux mixture produce a roughening and russeting of the fruit. With ammoniacal copper carbonate there is danger from late applications on fair skinned apples. There seems no question as to the benefit of spraying for bitter rot.

4. BROWN SPOTS BENEATH SKIN OF APPLE.

Specimens of apples of the Fameuse and Winter Bough varieties have been received from Professor John Craig, of Ottawa, Canada. These were affected with small, brown, dead spots just beneath the skin of the apple, and usually not extending to great depth. The same trouble is reported in this state on "Northern Spy," and perhaps upon other varieties. No fungus was discovered in any of these spots. It seems probable that they are due to a breaking down of the cells and the trouble may be influenced by conditions of the season. The apples thus affected are of small value.

5. LOCAL BLIGHTING OF BRANCHES AND TRUNK—SUN-SCALD

There is very general complaint, in the fruit growing counties of northern Ohio, that apple trees suffer from local blighting of branches and trunks. Upon younger trees the trunks suffer and the term "sun-scald" is commonly applied to it. The trouble is not confined to any section, though it is more prevalent in the northern portion of the state. It might further be added that the trunks of pear trees suffer in a similar manner.

By local blighting is meant dead spots of greater or less area upon the branches or trunk of the tree. These occur upon branches of almost any size, from a little less than an inch to several inches in diameter. The dead spots also are found upon any side of the branch, but more commonly upon the south or southwest side. In the dead spots the bark adheres firmly to the wood until it rots away. Often I have observed at this stage the development of higher fungi. It has not been determined that these are more than followers of the real trouble. As has been stated, the trouble is more frequent upon the south or southwest side of the tree. The explanation of this occurrence will come later. Trees leaning to the northeast may suffer worst of all. Baldwin and Duchess of Oldenburg have suffered severely, while some other sorts in the same orchard had little of the blighting. King of Tompkins, on the other hand, practically all died in an orchard with Baldwins, of which few have yet died. But in the case of the King it is not clear that a separation of the bark of the trunk from the wood near the surface of the ground due to winter injury did not cause much of the dying. This latter form of injury requires to be mentioned separately.

In the case of blighting on trunk and branches in spots, with bark

adhering in the blighted area, the so called sun-scald, Dr. Burrill[25] has found the bacterium of pear blight responsible for the injury.

The sun causes deeper cracking of the corky bark upon the exposed sides of trunk and branch, south and southwest sides. In early summer Dr. Burrill remarks that the cracks extend to the living cells, and thereby expose them to the contagion of the pear blight microbe. The bacteria once in the living tissue the results are such as those described. The same thing, according to Dr. Burrill, can be artificially brought about by inoculation with blight bacteria, and this succeeds as well on the north side of the tree as upon the south side. In some instances the tree may be saved, even when the blight microbe has entered the living cells. This may happen if the blight is confined to the cells outside the bast or fibrous layer of the inner bark.

The only remedial measures suggested are to keep the tree erect or leaning to the southwest, or to provide a shield from the sun. This prevents the bark from drying and cracking, and thus, while not preventive of the blight microbe in a direct sense, is a means of avoiding conditions under which it may work injury.

Allusion was made to the separation of the bark near the surface of the ground and the consequent death of trees or the production of dead areas. The form of injury here mentioned is the result of freezing. It is treated of in detail in the article to which I have just referred.[26] Late cultivation of apple orchards in autumn or favorable conditions for growth following drouth and the like, put the tissue in a condition to freeze where exceptional winter cold follows. The following are the suggestions as to remedies for this trouble:

"The evil consequence then of the summer's drouth is what we should in the first place strive to avoid. This may be accomplished in several ways known to us all, and I may only mention such as the choice of site, deep drainage to favor the penetration of roots into soil likely to be moist in summer, good surface cultivation during dry times, extensive mulching, selection of varieties possessing powers of withstanding drouth."

In the Ohio cases brought to my notice the conditions are such as these described. In Erie county two eight to ten-year-old orchards of Baldwins were practically ruined by winter freezing in 1881. In these the separation of bark was nearly always upon the southwest or south sides near the ground. Under the same circumstances Grimes' escaped with much less injury than the Baldwin.

---

[25] Climatal Destruction of Orchard Trees. Report of Univ. of Ills. 1876, 283-4.
[26] Burrill, loc. cit. 284-293.

This page intentionally blank.

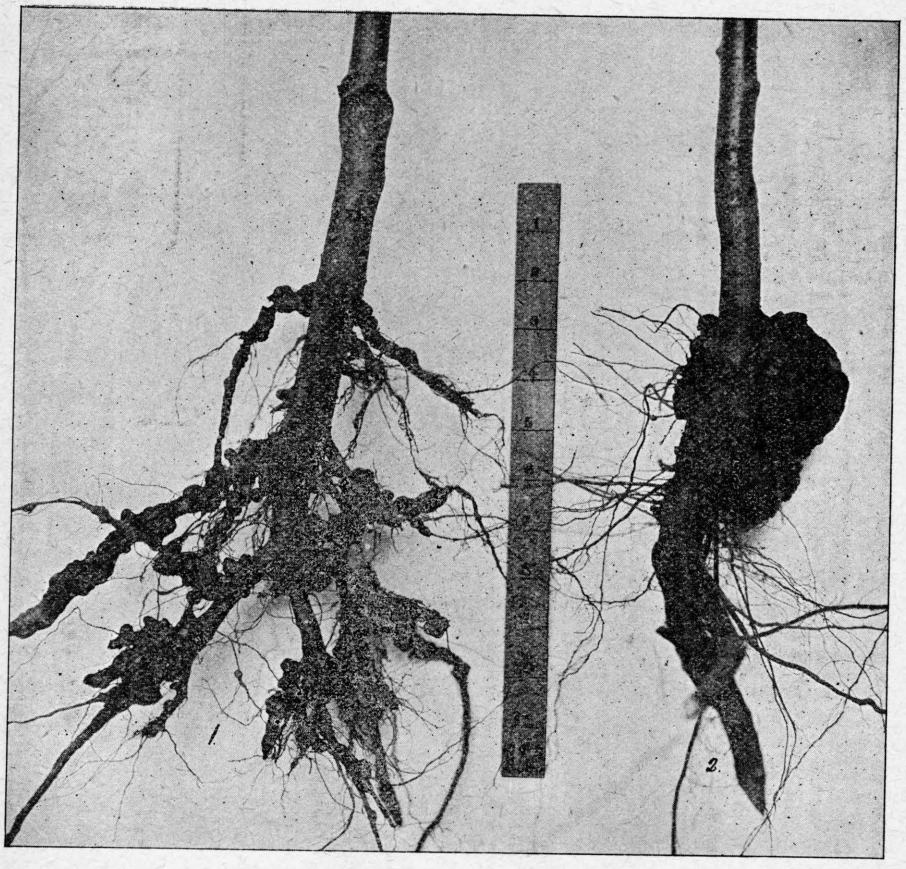


PLATE IX—GALL ON APPLE TREES.

1 shows bead galls of Golden Sweet, possibly different from those caused by the aphis. 2, crown gall on Ben Davis, in this case three and one-half inches in diameter. Both trees three years old. (Original.)

6. CROWN GALL ON APPLE.

In common with other rosaceous fruits apples suffer from enlargements upon the stem just below the surface of the ground and sometimes upon the roots. This may be distinguished from the effect of aphis by the greater size and the different appearance. The aphis commonly produces a series of bead-like enlargements upon the smaller roots. The crown gall is more commonly upon the stem, and, as stated, much larger and more roughened in exterior. At present we can make no rigid statements as to the crown gall of apple. The writer has found eel-worms in some of the smaller enlargements upon the stem. It seems unlikely that such affected trees will be worth planting, and all of them suffering from this trouble should be burned.

ACKNOWLEDGEMENTS.

I desire to express my obligations to a number of persons for assistance in the studies for this bulletin. Messrs. W. N. and Chas. E. Yost, of Fulton county, have assisted by specimens of diseased raspberry plants and by reports upon the diseased plantations. Similar assistance was rendered by Mr. S. L. Hill, of Erie county. The Storrs & Harrison Co., of Painesville, contributed a number of apple trees which came into their hands affected with root galls; also a number of imported pear stocks with the same malady. Several others have also assisted in various ways. Of the illustrations, the drawings for figs. 1 and 4 were made by my wife; the drawings of figs. 1, 2, 3 and 5, plate V, and figs. 8 (in part) 9 and 10, by Miss F. Detmers; those of figs. 8 (in part) and 9, by Miss Clara Blesch; fig. 7, by Miss V. Cunningham. Plates III and IX are from photographs by E. P. Osborne and fig. 2 from a photograph by the writer. The sources of other illustrations have been indicated in the text.

SUMMARY.

1. Currants and gooseberries were seriously defoliated in Ohio by the leaf spot fungus (*Septoria ribis* Desm.). The injuries caused by it may be prevented by thorough spraying with Bordeaux mixture. Gooseberries also suffer from mildew; this may likewise be prevented by the use of fungicides.

2. Anthracnose and rust prevail upon raspberries and blackberries; leaf-spot fungus also attacks dewberries. The anthracnose has been successfully prevented by spraying with Bordeaux mixture if care is used in the application; the leaf spot should be amenable to the same treatment, while the removal of rusted plants is the best procedure for rust.

3. Raspberries and blackberries are likewise affected by a serious gall disease of the roots and stems referred to "crown gall." All varieties appear to be susceptible to the trouble and nearly all woody stemmed fruit trees as well. In the case of one variety the crown gall is attributed to the attacks of microscopic worms called nematodes or eelworms. Removal of affected plants and their destruction by fire are suggested as preventive measures for this gall. Raspberries and blackberries may infect young orchards if planted among the trees.

4. Rot, black-knot, shot-hole fungus and mildew are the principal diseases of plums and cherries. The shot-hole fungus and mildew can be successfully prevented by two or three sprayings with Bordeaux mixture, beginning when the leaves are half grown; for cherries, only one-half the usual strength of mixture may be used without injury to the foliage. Black-knot is best controlled by the removal and burning of all knots. Spraying to prevent rot, while promising well, has not passed the experimental stage; removal of all rotted, mummy fruits is the first essential to successful rot prevention.

5. Both the fruit and twigs of plums are attacked by "plum pockets;" removal of diseased parts or early spraying are recommended for its prevention. Plums certainly, and perhaps cherries, are affected by a seriou disease of twigs and branches followed by gum-flow. The cause of this disease is unknown.

6. Many sorts of fruit trees are attacked by fire blight, or pear blight; the pear, apple, quince and some others are seriously injured by the blight. Thorough removal and burning of all blighted wood, in fall or early winter, to exterminate the blight microbe, is a practicable method to check the ravages of the blight.

7. The fungous diseases of pears and quinces are somewhat similar and are prevented by the careful use of fungicides. The pear is also affected by crown gall, for which the same measures of prevention are recommended as for raspberries and blackberries.

8. The apple scab fungus continues the chief enemy to profitable apple growing. The value of spraying to prevent its injuries is well established. This spraying treatment for the purpose of securing crops of apples is strongly urged.

9. An old, fungous enemy, probably *Leptothyrium pomi* (Mont and Fr.) damaged apples badly during the wet season of 1896. It causes sooty and fly-speck spots upon the surface of the fruit and greatly impairs the market value of the fruit. It is well established that spraying with Bordeaux readily prevents this spotting.

10. A local blighting of the branches and trunks of apple trees, commonly called "sun-scald," is referred to the effects of the bacterium of pear blight, which gains entrance through cracks caused by drying of the outer bark. Crown gall is also found upon the apple tree. The remedy is the same as upon other plants, namely: burning all diseased trees.

11. A spray calendar, prepared by the Station Horticulturist, Entomologist and Botanist, upon request, is published as a supplement to this bulletin. It may be put up in the fruit house for easy reference in spraying. It may here be added that fungicidal and insecticidal treatment of orchard trees seems now essential to successful growing of orchard fruits.

This page intentionally blank.